Lessons Learned from Application of Software Agent and Decision Support Technologies to Operator and Operational Effectiveness

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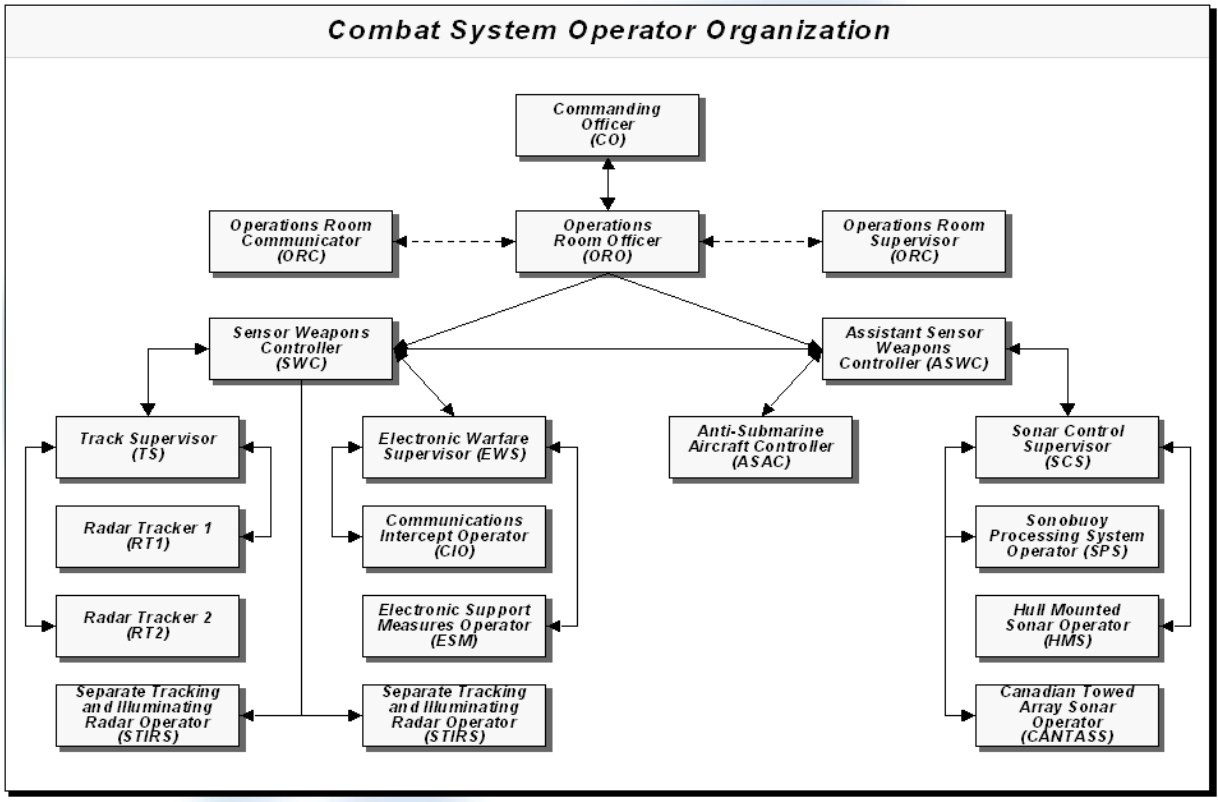
Overview

- Tasks and role of naval operators in traditional system
- Tasks and role of operators in system employing automated detection and tracking and MSDF
- Impact of change on operator and operational effectiveness
  - based on research with other systems
  - based on observation of performance with real systems
- Integration of DCIEM research with existing knowledge base
- Conclusions

Traditional system

- Sensor Operator
  - searches incoming data for possible targets
  - detects, tracks and analyses possible targets
  - passes on reports of possible targets
- Track Supervisor
  - adds new contacts to tactical display
  - updates position of existing contacts
  - correlates contacts



Traditional system (2)

- Warfare Director
  - coordinates tactical picture
  - recommends classification
  - provides command with update of tactical picture

Why introduce automation

- More sensitive sensors and increased computing power
  - amount of data increased substantively
- Increase in number and type of sources of information
- New concept of operations
  - littoral versus deep water - more contacts, more noise
- Reduced manning
  - fewer operators to interrogate data
- It is possible

New concept ?

- Sensor Operator
  - monitors output of automated system that detects, tracks and does preliminary classification of contacts
  - compares automated system's decisions with current tactical and environmental picture
  - interrogates data if necessary
  - removes false alarms and passes on possible contacts

New concept ? (2)

- Track Supervisor
  - monitors output of combat data fusion system that fuses output of sensors with information from other sources
  - queries system as to status of contacts, sources etc.
- Warfare Director
  - monitors output of multi-sensor data fusion system
  - recommends classification
  - provides command with update of tactical picture

Research on use of automated systems

- Humans tend not to use automated systems if they perceive them as unreliable
- Even if they are perceived as reliable, humans may not use the system in order to maintain control
- If system is reliable and used, the human often fails to monitor it adequately
- Use of automated systems can lead to loss of skills so operator unable to intervene
- Automation errors often difficult to detect because of inadequate feedback

Caveat

- Most of the research on human use of automation centered on cockpit automation and process control
- Frequently automated tasks can be carried out manually
- Automation introduced to
  - reduce workload
  - reduce error rate
  - increase number of tasks that a single operator can monitor

Review by Klein Associates Inc.

- Looked specifically at potential impact of Multi-Sensor Data Fusion (MSDF)
- Reviewed in context of Naturalistic Decision Making
- Based on:
  - literature discussed previously
  - experience with wide range of U.S. military systems
- Focus critical

Potential problems with MSDF

- Interferes with application of expertise
  - Reduces evaluation of data when integration of sources automatic
  - see what system found and not what missed
- Interferes with expertise of team
  - verbal or written communication shared by everyone
- Slows rate of learning of novices
  - less requirement to deal with data
  - less capability to handle task if automation fails
  - less capability to detect anomalies

DCIEM research

- Initiated because of observed operator dissatisfaction with automated detection and tracking systems
- Generic target tracking task
  - later added automated detection capability
- Details of studies reported in series of presentations and papers
- Compare findings with other research and concerns of Klein

Automated tracking

- Use of moderately reliable tracker depended on:
  - number of targets that had to be tracked
  - capability of individual to do task manually
  - experience with automated tracker
- Even moderately reliable tracker:
  - perceived as reducing workload
  - reduced time on task
- As reliability increased:
  - detection of low strength targets increased
  - detection of automation errors appeared to decrease

Automated tracking (2)

- Initial experience with manual task:
  - did not result in better system performance
  - delayed learning how to find low strength targets
- Detection of automation errors:
  - little evidence that it was due to complacency
  - poorest when busy handling other tasks such as target detection
  - suggests due to relatively low visibility of those type of errors

Automated detection and tracking

- Varied detection threshold and tracking reliability
- Little variation in performance across conditions
- Best performance with low detection threshold and moderate reliability
  - less time to remove false alarms - more likely that low strength targets added by ADT
  - targets not updated as consistently - automation errors corrected
- No improvement in detection of automation errors under high reliability tracker

Automated detection and tracking (2)

- Provided capability to adjust detection threshold and tracking reliability
- Most users:
  - chose a detection threshold that minimized false alarms
  - tracker parameters that resulted in tracks being consistently updated
- Performance similar to high reliability, high threshold condition in previous study
  - preferred to let automation handle standard tracks and search for low strength targets manually

Conclusion

- Automation does allow operators to handle higher workload
  - performance likely to be higher than if tried to do task manually but will likely miss anomalies
- Most users make maximum use of automation unless seen as increasing workload
  - Any efforts to increase operator involvement has to be perceived as beneficial in short term
  - Need to force interaction with system in intelligent manner

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